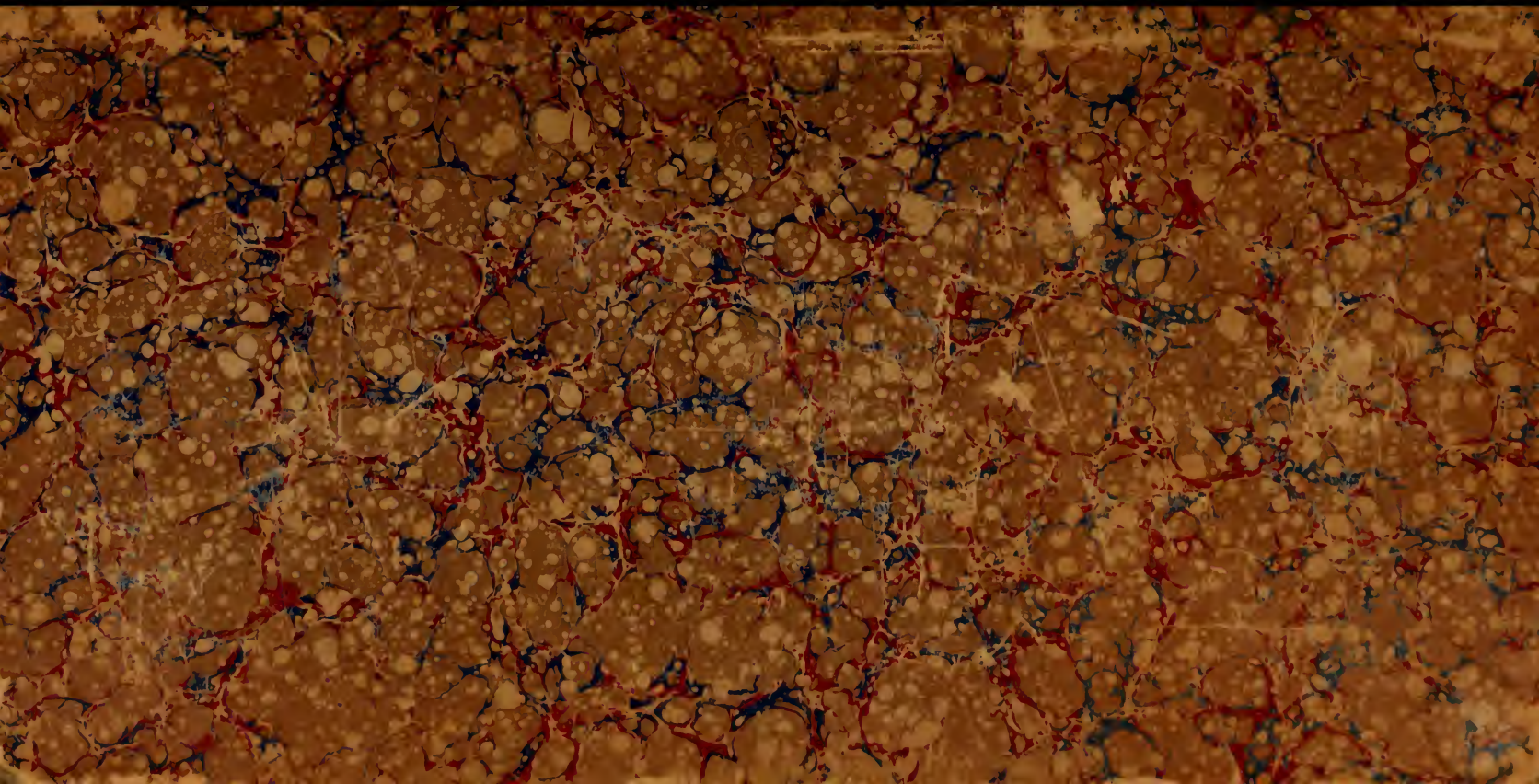


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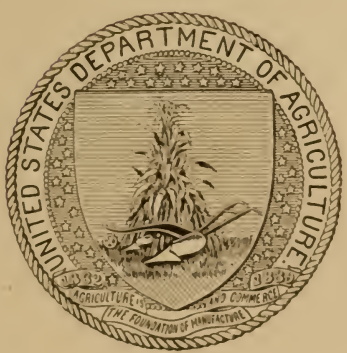
HORNED LARKS FEEDING ON AMARANTH.

U. S. DEPARTMENT OF AGRICULTURE
BIOLOGICAL SURVEY—BULLETIN No. 23
C. HART MERRIAM, Chief

# THE HORNED LARKS AND THEIR RELATION TO AGRICULTURE

BY

W. L. McATEE
Assistant, Biological Survey




WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey.
*Washington, D. C., September 1, 1905.*

Sir: I have the honor to transmit herewith for publication as Bulletin No. 23 of the Biological Survey a report on the Horned Larks and their Relation to Agriculture, by W. L. McAtee, an assistant in the Biological Survey. The horned larks, though of small size, form an important group economically because of their very general distribution, their great numbers, and their food habits. As a result of the present investigation it appears that though these birds feed to some extent upon grain the actual damage done is slight, because the grain eaten is mostly waste. On the other hand, the birds are shown to feed very largely upon insects and weed seeds, among which are some of the worst pests that the farmer has to contend with. The horned larks, therefore, should be classed among the species highly beneficial to agriculture.

Respectfully,

C. Hart Merriam,
*Chief, Biological Survey.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# THE HORNED LARKS AND THEIR RELATION TO AGRICULTURE.

## DISTRIBUTION AND HABITS.

The horned larks are small but hardy birds which frequent the open country and never live in forests. They are found in a great variety of situations, and feed along roads, in weedy or freshly plowed fields, on commons or other waste places, and in closely grazed pastures, meadows, and stubble fields. The beaches and salt marshes of the coasts, the lake shores, muddy flats, and swamps of the interior are thronged with them in fall and winter. In the far West they live in hot desert valleys, on arid table-lands, on level grassy prairies, in the foothills, and even on bare mountain peaks.

They are readily distinguished from other small ground-loving birds. They are about the size of the bluebird, their throats are white or yellow, there is a conspicuous black mark across the breast, and just above and behind the eyes are small pointed tufts of dark-colored feathers which are often erected. These black tufts or horns are perhaps the bird's most characteristic feature, and give origin to the common name 'horned lark,' by which it is known over most of the United States. 'Shore lark' is another common name, though a less apt one. The various subspecies are distinguished by names which convey an idea of the surroundings of the bird or of its appearance—prairie, desert, scorched, and pallid horned lark being examples of these designations. West of the Mississippi several names indicative of the bird's habits are used, among them being 'prairie bird', 'road trotter,' and 'wheat bird.' In parts of Canada it is known as 'spring' or 'life bird,' in allusion, no doubt, to its reappearance in the vernal season.

Many of the popular names of the horned larks emphasize the fact that they are preeminently terrestrial birds. During the day they run nimbly over the surface in quest of food; at night they roost in small companies on the bare earth. A clod or stone is a favorite perch, and they are rarely seen in a bush or tree.

They nest early, the first clutch of eggs often being completed before the snow has disappeared. The nests are of the simplest description,

in keeping with the artless character of the bird, being little cups of grass placed in slight depressions in the ground. Two or even three broods are raised in a year, a fact which sufficiently explains the great numbers of the species in some localities.

The flight of the horned larks is hesitant. They usually start hurriedly from the ground, uttering short, whistled notes, and it is very characteristic of them that frequently when disturbed they fly straight away for a short distance, only to swing around and alight near the starting point. In the mating season, however, they ascend to great heights and, like the skylark, sing while on the wing. The song is neither complex nor loud, but it is wild, joyous, and full of the free spirit of the prairie and the open fields.

The birds thus characterized occur at some time of the year in all parts of North America, except the Aleutian Islands, the southern coastal portion of Alaska, extreme southeastern United States, and Central America. This vast range is occupied by only one species, which, however, varies so greatly in different localities that it has been separated into no fewer than twenty-one varieties or subspecies.[a]

During the breeding season these geographic forms are restricted to separate areas, but in winter, on account of the tendency of the southern races to wander and of the northern ones to migrate, the subspecies mingle, and as many as seven (Arizona) or eight (California) forms occur in one State. In summer in the United States (including Alaska) there are fifteen subspecies of horned larks, and in winter seventeen.

The several members of the family *Alaudidæ*, which includes these forms, are interesting birds. Their habit of walking, instead of hopping, distinguishes them from many small ground birds. They have long hind claws, the prints of which in the snow or along the muddy shores of ponds often indicate where the larks have been running. They molt but once a year, usually in August, while many birds molt twice and a few three times. The nuptial dress is acquired not by molting, but by the wearing away of the tips of the winter feathers, revealing the brighter colors beneath. The plumage of the larks is generally neutral in tint, especially when viewed from above, and so harmonizes with their surroundings that it has a protective value, and enables the birds, in a measure, to escape the notice of enemies.

## GENERAL FOOD HABITS AND ECONOMIC RELATIONS.

A preliminary report upon the food of the horned larks, by Prof. Walter B. Barrows, formerly of the Biological Survey, was published in the Report of the Secretary of Agriculture for 1892. It was based

[a] For descriptions and ranges of the subspecific forms the reader is referred to H. C Oberholser's 'Review of the Larks of the Genus Otocoris;' Proceedings of the U. S., Nat. Museum, Vol. XXIV, pp. 801–880, 1902.

upon the examination of 59 stomachs. A much larger amount of material is available for the present paper, no fewer than 1,154 stomachs having been examined. The present material represents also a much greater area, coming from no fewer than twenty-five States and Territories, and in addition the District of Columbia, Ontario, Saskatchewan, and Mackenzie. Among the specimens collected are nestling, adolescent, and adult birds, including representatives of eleven subspecies.

The food habits of the several forms are very similar with the exception of the central and southern California bird (*Otocoris alpestris actia* Oberh.), which is so anomalous in its feeding habits that it has been deemed advisable to treat it also separately.

Professor Barrows found that the horned larks examined by him had consumed during the year 11.42 percent of animal matter and 88.58 percent of vegetable matter. The present investigation results in a somewhat different showing for the birds, there being in the food more insects and less vegetable elements, or 20.6 percent of animal and 79.4 percent of vegetable matter.

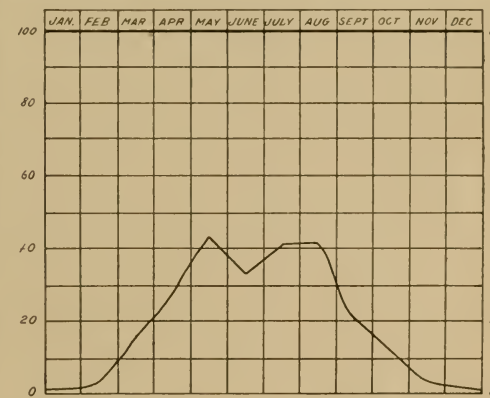



FIG. 1.—Diagram showing the proportions of animal and vegetable food of the horned larks of the United States, exclusive of the members of the subspecies *Otocoris a. actia*, for every month in the year. [Read the column of figures on the left from the bottom upward for the percentage of animal food, and the column on the right from the top downward for the percentage of vegetable food. The area below the curve represents the total amount of animal food for the year, and that above, the vegetable food.]

From the accompanying chart (fig. 1) the proportions of the components of the food for each month may be seen at a glance. Very little animal matter is obtained during the winter months. The few insects alive at this season are usually well concealed and the wonder is that the birds obtain any of them. In January, animal matter, consisting principally of weevils and cocoons of tineid moths, composes only 1.73 percent of the food. In February about the same things are eaten, but in larger amount, making 3.11 percent. The percentage rises rapidly in March and April, principally because of an increase in the number of weevils, caterpillars, and bugs eaten, although beetle larvæ and leaf beetles also are consumed in larger amount. In these months the horned larks obtain respectively 15.72 percent and 27.31 percent of animal matter. April is the first month when the amount of animal matter eaten is in excess of the

monthly average, and it is consumed by the adults alone. This result is in harmony with the observed fact that the breeding season taxes the strength of birds, and hence an easily assimilated, highly nutritious food is required.

In May there is a further increase in the amount of animal food eaten, the maximum (43.4 percent) for the year being reached. The percentage is higher in this month because there are included in the computations several nestlings, which were fed almost exclusively upon insects. However, the adults also consume more animal food at this time, and the adolescent birds, while they do not eat as large an amount as their parents, have not developed the strong vegetarian taste which characterizes them later. The principal elements of the animal food in May are weevils, May beetles (insects more commonly known as June bugs), caterpillars, and grasshoppers. In June the amount of insects eaten becomes smaller. The former nestlings, now independent of the old birds, are largely vegetarian, and counteract the influence of the adults, which are even more insectivorous in this month than in May. More weevils, leaf beetles, and ants are eaten in June than in May, but fewer May beetles, caterpillars, and grasshoppers.

From May to August the proportion of animal food would probably be about the same in each month were it not for the peculiar diet of the young birds. The consumption of the maximum number of insects in May is the result of the influence of the nestlings and adolescent larks. The former, being highly insectivorous, raise the percentage in May, while the adolescent birds, because of the opposite trait, tend to lower the percentage in June, July, and August. When the diet of the adults alone is considered, the proportion of animal food for the latter part of the summer increases, and the maximum comes, as in the case of a great many other species, in August. (See fig. 2.) Two factors tend to raise the percentage of animal food in this month—first, the molt, which in many cases is known to create a ravenous appetite for such food, and, second, the great abundance of insects, particularly grasshoppers, these in August forming the bulk of the animal food of many species of birds. Although horned larks eat a considerable number of grasshoppers, they consume a greater number of weevils than of any other insects. These small, inconspicuously colored insects, most of which are actual or incipient pests of the worst kind, constitute nearly 18 percent of the food in August. After this month the amount of animal food decreases rapidly. Caterpillars, grasshoppers, beetle larvæ, scarabæid and carabid beetles are soon entirely lacking. The lowest point in the entire year for the consumption of animal food is reached in December, when only 1 percent is obtained. During the winter

months, when little animal matter is eaten and the amount of vegetable food is at its maximum, considerable grain is consumed, but about three-fourths of the food are weed seed.

Few examinations of the stomachs of horned larks have been made except in the Biological Survey, most ornithologists contenting themselves with casual field observations on the food habits. Examination of all accessible accounts reveals but few items of food not met with in the course of the present investigation, these being such unimportant substances as minute crustaceans, cactus seeds, and plant buds, none of which are commonly eaten.

The food habits of the horned lark—*Otocoris alpestris flava* (Gmelin)—of Europe, judging from published accounts, are essentially like those of our own forms, to which it is closely related. In Germany another species, the skylark, in recognition of its value as an insect destroyer, is protected by law from May to September 15;[a] but at other seasons it is taken in nets in large numbers for food.

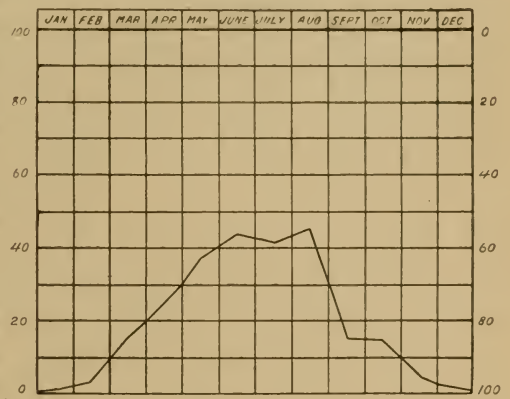



FIG. 2.—Diagram showing the proportions of animal and vegetable food of the adult horned larks for every month in the year.

In former times larks were much used for food also in the United States. They occur in flocks in winter, are easily trapped, and years ago the markets of many of our large cities were abundantly supplied with them. This traffic has not entirely ceased at the present time. In 1891[b] W. E. Bryant wrote concerning the marketing of horned larks:

> For an indefinite number of years there have been exposed for sale in the markets of San Francisco * * * small Californian birds, * * * the so-called 'reed birds.' * * * A San Francisco 'reed bird' * * * generally speaking is a horned lark (*Otocoris*), known to the market men and pot hunters who furnish them as 'bean birds.' Fifteen years or more ago this bird was almost the only species killed for this purpose, but the long-continued, persistent slaying of this species, together with the increase of settlement, making it necessary to journey farther after them, has resulted in the substitution of most any other species of about the same size in place of them. * * * The annual destruction must amount to many thousands.

However, of recent years the economic value of horned larks has become better understood, and at present they are protected through

[a] Hermann Fürst, Deutschland's nützliche und schädliche Vögel, p. 63, 1893.

[b] Zoe, II, pp. 142–144, 1891.

out the year in all but five of the States in which they regularly occur, and in no State are they specifically exempted from protection. In consequence comparatively few horned larks are now captured for food.

But man is not the only enemy of the larks. Because of the openness of the country they inhabit, they are always in more or less danger from hawks and owls, and the following species have been known to kill them: Red-tailed hawk, red-shouldered hawk, marsh hawk, prairie falcon, and burrowing and screech owls. Shrikes also capture them.

While the fondness of the horned larks for open country thus exposes them to the attacks of rapacious birds, in farming regions it leads them to live on cultivated land, where they enjoy the protection of man. Here they are but slightly affected by the farming operations which drive away many birds. They build their nests on the ground in exposed situations, and neither woods, shrubbery, nor other protecting growths are needed to induce them to nest on the farm. In spring the wheat fields, pastures, and meadows not yet rankly covered are chosen as nesting sites; early summer finds them with their second brood in the fields of young corn, and still more belated pairs make their homes in the stubble fields. In winter, feeding lots, barnyards, and all open fields are favorite foraging grounds, and often they may be seen searching for food along the much-frequented country road. For several years the writer knew of a meadow where these birds built their nests and reared their young. They fed in the adjoining road and in a cornfield opposite, and were to be found here the year through. From these facts it appears that at every season the horned lark is closely identified with the farm and thus with the farmer's welfare.

Of the birds examined for the purposes of this bulletin, and accompanied by full data, about four individuals were taken on farming land to one taken in uncultivated places. About one-half of the former number had eaten insects, somewhat over a third had taken grain of some kind, and practically all had eaten weed seeds. As explained elsewhere, most of the grain is obtained along roads and in stubble, and hence no injury is done to the farmer. Of the number found away from farming regions all had eaten weed seeds, nine-tenths had consumed insects, and about one-half had taken grain. Those larks which occur far from cultivated lands, while not directly beneficial to the farmer, undoubtedly aid him indirectly by destroying harmful insects and weeds which might spread to the farms.

## VEGETABLE FOOD.

No less than 79.4 percent of the food of the horned larks is vegetable matter. Of a total of 1,154 birds examined only 22 had eaten

no vegetable matter, while in some form or other it made up the entire stomach contents of 634. In this portion of the food are represented no fewer than 105 species of plants. This great variety may be classed for economic consideration under the following heads: Weeds, forage plants, fruits, and grain.

### GRAIN.

Grain furnishes 40.2 percent of the food of the horned larks in California and 12.2 percent of that of the larks in the rest of the country. Oats, corn, and wheat form the bulk of this, kafir corn and buckwheat being taken in insignificant amounts.

Were all of the grain eaten by horned larks a direct loss to the farmer, the damage would be considerable. But such is not the case. As would be expected from birds so essentially terrestrial in habits, horned larks do not injure standing grain, nor do they feed upon grain in stacks and shocks. The grain they obtain from the surface is either newly sown seed or waste, and as the latter is lost to the farmer in any event, it is safe to conclude that whatever damage the birds do occurs in sowing time.

### WHEAT.

Wheat is damaged more than other grain crops during the sowing season, and the injury is greater in California than elsewhere. Details of the ravages of the larks in this State are given by several correspondents. A. A. Eaton, of Riverdale, Fresno County, writes substantially as follows:

> I believe the worst pests in the bird line farmers have to endure are the horned larks. In winter they come in thousands and eat wheat sown broadcast so badly that I have had to drill it in. They leave the whole wheat, however, as soon as they find any that has sprouted. They then select spots, generally where there have been some weeds, and pull up, and even scratch, in the manner of a hen, the better to get at the whole. In such places not a stalk is left standing.

M. S. Featherstone, of Goshen, Tulare County, which is in the midst of the best wheat-growing section of the State, says:

> Small brown birds which we call wheat birds are quite numerous during the sowing season some years. Ten or twelve years ago they were unusually active, and many people sowed poisoned wheat and left it on top of the ground to destroy them before the regular sowing. I had about 4 acres left, not harrowed, one Saturday night, and every kernel was gone by Monday morning, picked up by the wheat birds and meadow larks. During the latter part of January and the first part of February last year (1895) wheat birds were plentiful and did much damage. The early sown grain was not injured by them. I put out some poisoned grain (a gallon or so), and my boys picked up about 600 in a few days. They also found 3 mourning doves and some meadow larks (a dozen or two). I think the wheat birds also pull up the sprouting grain. These little birds are yellowish on the throat and fly in flocks. I have not noticed them except in the early spring.

Mr. E. W. Nelson, of the Biological Survey, in writing about the California horned lark in 1893, stated:

> This species is excessively abundant in the San Joaquin Valley of California, east of Tulare Lake. In autumn they gather in enormous flocks, containing hundreds of birds, and continue together until spring. When the farmers sow their winter wheat on these plains the shore larks swarm over the fields in countless numbers, scratching up and greedily devouring the grain. They do this so persistently that fields are sometimes replanted on account of their depredations, and all fields are considerably damaged by them.

Such direct evidence as the above, from observations in the field, establishes beyond doubt that in wheat fields, newly sown broadcast, the horned lark is a pest, and this conclusion is corroborated by the results of stomach examinations.

Before discussing these it will be well to outline the conditions of grain raising in California. The Sacramento and the San Joaquin river valleys and the coastal region from San Francisco south are the important wheat-growing areas, and it is precisely in these places that the horned larks are most numerous during the second sowing time. This occurs in January and February, the first being late in summer (August and September) before the first fall rain, or immediately after it if the soil can not be worked before. Thus there are two periods in the year during which wheat is exposed to attacks of the larks.

Since horned larks are present only in small numbers during the first sowing season, the possibilities of injury from them are not great; moreover, that the birds present eat little wheat appears from the fact that none of it was found in the stomachs of any of the horned larks from California, in number over 150, which were collected from August to the end of the year.

During the winter sowing, however, the horned larks are abundant, and then it is that complaints are made of their wheat-eating habits, complaints which our investigations show are not unfounded. Wheat constituted 14.1 percent of the food of 21 birds collected in January and 74 percent of that of 5 birds taken in February. However, all of the wheat taken in January was in the stomachs of 3 specimens from Escondido, San Diego County, and it made 99 percent of their contents. The high percentage of wheat in the food in February is partly due to the small number of specimens examined, namely, 5. Three of these, however, were shot from a flock of birds which were 'supposed to be pulling wheat,' and thus were caught in the very act. These, also, were taken at Escondido, and contained an average of 93.3 percent of wheat.

These facts justify the conclusion that horned larks eat wheat whenever they can find it. It forms only 9.1 percent of the year's food of the California horned larks, but as most of this is seed grain

the damage is greater than implied by the figures. However, it is to be noted that all of the wheat eaten at this time comes from fields sown broadcast, and that absolutely nothing is done by the farmers to protect the seed. The very best protective measure—drilling—costs no more than broadcasting, except for very small areas, and besides completely protecting the wheat from the birds, it has the further advantages that it increases the yield per acre and also improves the quality of the grain.

Joseph Mailliard, of San Geronimo, Marin County, Cal., writes (July, 1905):

> Grain is drilled in to quite an extent now, but the majority of the large grain fields are sown with the broadcasting machine on account of greater rapidity. This leaves more or less grain on and near the surface, which naturally falls a prey to certain species of birds when conditions are right. I should say that the horned larks would only attack grain when food was scarce in their own feeding grounds, which are usually grass-grown meadows and uplands.

Lyman Belding, of Stockton, San Joaquin County, who has had many years of experience in the California grain country, says (July, 1905):

> As far as my observation goes there is less wheat planted by drills late years than formerly.

Concerning the depredations of the larks he continues:

> I can say positively that the damage done by these birds in California is not worthy of the least consideration, because the shore larks are not numerous and we have millions of acres of wheat. Like our meadow lark and Brewer's blackbird, the damage done by them would only be noticeable on a small field of wheat that was much later than adjoining wheat fields; but, unlike the meadow lark and blackbird, it does not probe the ground for the wheat kernel—it merely eats a little wheat that is on the surface of the ground not yet covered by the harrow in seeding time. I have observed them closely in Butte and this county, and am positive the statement made above is correct.

Comparing the above with previous quotations it is seen that opinions differ concerning the economic status of the horned larks, but that at the present time the consensus of opinion is favorable to the bird.

It appears that injury from the larks is suffered also in the spring-wheat region of the central plains. Charles L. King, of Millbank, S. Dak., writes:

> There is a bird called wheat bird * * * that comes in early spring in great numbers when the farmer is sowing grain, and all grain left on top of the ground is very soon picked up.

T. P. Lindley, of St. Ansgar, S. Dak., corroborates this by the following testimony:

> The worst birds we have in Dakota are small prairie birds. They eat wheat while it is being sown. They are small, but so numerous that they take one-third to one-half of the crop if it is left uncovered for a day or two. They do not dig the wheat out, but pick it up before it is covered.

In the following letter George Lang, of Indian Head, Assiniboia, describes the depredations of the lark in greater detail, and points out that the use of deep planting drills has rendered the birds harmless:

The damage is done as a rule about the first two weeks in May while the wheat is in the first leaf. I have examined the stomachs of hundreds of specimens, and in almost every case I found grains of wheat. These birds, in company with snow buntings and chestnut-collared buntings, are here in millions from about April 15 to May 15. They pick up all uncovered kernels first and then as soon as the young shoots appear above ground they follow up the rows and pull up the stalk, eating only the sprouted kernel, and leave the leaf lying on the ground. Of course they break off a great many more than they uproot, but still they thin out the grain to quite an extent. In earlier years, before we began using drills for seeding wheat, we always counted on one-half bushel to the acre for the grain birds, as we counted they would pick up that amount. I know of fields that had to be seeded over the second time where the harrows were not kept close up to the seeder. I have also been driven to poisoning wheat and scattering around the fields. Of late years we do not notice these birds so much. I suppose on account of the increased acreage the birds are more scattered, and also on account of the press drills putting the seed too deep for the birds to uproot.

As in the case of the California larks, stomach examinations confirm field observations with regard to the grain-eating habits of the larks of the central plains wheat region. Of 23 stomachs of horned larks collected here in April and the same number in May, 46 in all, 11 contained wheat. Seven of these were collected on April 5 in a newly sown wheat field at Kennedy, Nebr., and all held wheat. The average amount for the 7 was 28.4 percent, and no individual had taken more than 35 percent. The remainder of the food was weed seeds. These were seeds of sunflower, tumbleweed, and pigweed. Thus the birds which had made something over a fourth of their meal of wheat had eaten nearly three times that amount of the seeds of the worst weeds in the country. If fully a third of their food had been wheat, the average percentage of grain for the whole 46 would be only slightly over 7 percent, an amount clearly too trivial to warrant the condemnation of the birds, especially in view of the fact that the remainder of their food consists of the seeds of noxious weeds.

It is of importance to note that the complaints quoted above were made several years ago when broadcast sowing was the rule. Recent correspondence shows that drilled fields of wheat are practically safe from injury by the birds.

### CORN.

Corn constitutes 4.97 percent of the food of the horned larks. Since it is always planted rather deeply, seed corn is quite out of their reach, and even grains lying on the surface in a condition to germinate are probably not eaten by these birds, since the grain is too large to be swallowed whole, and their weak bills are entirely inadequate to the

task of breaking up the kernels. The writer watched horned larks feeding on prairie land in Indiana where many whole grains of corn were scattered about, and found that they passed them by.

Nearly all of the corn consumed is obtained in the winter, and none is eaten in August, September, and October. Many fragments taken in winter are exceedingly hard and apparently are not much affected by digestion, and the larks would certainly fare badly if much of their food were of this character; but gleaning constantly as they do along the roads, in barnyards, and feeding lots, they get many fragments of corn from the droppings of farm animals. From these sources, and from fields where the grain has been crushed by the tires of wagons and the hoofs of cattle, comes a great part of the corn they consume.

Consideration of the above facts shows that practically all of the corn eaten by the horned larks is waste, and hence is of no value to the farmer.

### OATS.

Oats constitute the greater bulk of the grain eaten by the horned larks, and it is of interest to note that the major portion of this grain taken, as well as that of wheat, is consumed by the horned larks of California. The latter eat oats to the extent of 31.1 percent of their food, while in the rest of the country the larks consume only 4.86 percent. During sowing time in the country east of the Rockies only a small percentage of oats is eaten. One bird was collected in a newly sown oat field in Michigan, March 31, and no trace of oats was found in its stomach.

Nearly nine-tenths of all the oats consumed in the year are eaten during the months from September to January, inclusive. In the Eastern States all grain eaten at this season is waste, but as the sowing in California occurs in October or in February, oats eaten in this State during these months may lessen the crop. No horned larks were collected in newly sown oat fields in California, but from data accompanying the birds it seems that stubble feeding is a common habit from October to January. Where the ground is broken up every year the stubble grain is of no consequence; but if a volunteer crop is depended on, then every grain taken from a stubble field lessens the succeeding crop. Even in the latter case, where it must be admitted that the larks do a certain amount of injury, it must not be forgotten that they eat ants and weevils which are injurious to crops, and that they devour the seeds of weeds which might render the hay crop almost worthless.

Oats grow wild everywhere in California and are inclined to remain tenaciously on ground once occupied. Professor Beal, after studying conditions in this State, considers that, in general, oats found in the

stomachs of California birds should be regarded as weed seed. Wild oats and those wasted in handling the cultivated crops must furnish practically all of this grain eaten by these larks, since there appears to be no evidence that they injure cultivated oats at any time.

### OTHER GRAINS AND FORAGE PLANTS.

Buckwheat is the most important of the other grains eaten by horned larks. All of it is consumed in June and July, and it may be, therefore, scattered grain from the early crop, or seed sown for the later one. Only nine birds of the entire number examined had eaten buckwheat, and it constitutes but little more than one-half of 1 per cent of the food of the year. Kafir corn and other sorghum seeds were eaten by some of the horned larks, but altogether they make up less than 1 percent of the total food, and all of this must be waste grain.

Some slight injury to a few of the forage plants may be mentioned here. Professor Barrows in his report noted the case of about sixty birds which were taken in a newly sown millet field in Michigan. Most of these birds had eaten millet seeds to some extent. This is the only instance noted in which the horned larks are known to have eaten cultivated millet, though they eat great quantities of the seeds of the wild species. Some grasses of the genus *Paspalum* are included among the forage plants, but most of these are unmitigated nuisances as weeds. To sum up this part of the subject, it may be said that if any injury to forage plants is done by the horned larks, it is too trifling for serious consideration.

The loss to grain growers through the agency of the horned larks is not, however, to be waived aside as of no moment. While it is true that on most farms in the United States enough grain is wasted to feed all the wild birds that occur on them, sometimes grain is eaten that is not waste, as in the instances above cited. Admitting, then, that the shore larks destroy a certain amount of grain, it may be said that whenever the damage to crops by birds is excessive there is an easier as well as a better method of dealing with them than by their wholesale destruction. It is the part of good husbandry to build and keep in repair fences about grain fields to prevent cattle from injuring the crops, and no one thinks of shooting the animals when they break through. We simply strengthen the defenses. The birds should be dealt with in the same fair-minded way, having due regard to the fact that they are generally useful and valuable allies, and that the damage they occasionally do can be rendered insignificant or wholly prevented by simple and inexpensive means. The use of a modern press drill in sowing grain is the best of these, and is sufficient

in itself to prevent practically all of the damage to grain crops by the horned larks.

Finally, it may be said in the bird's favor that at the worst the damage to grain from the horned lark is not great, and that it is more than counterbalanced by the good done through the destruction of harmful insects and the seeds of injurious weeds.

### Weeds.

The plants commonly known as weeds, from their injurious effect upon agriculture, are more important than any of the other enemies of the farmer. They rob the soil of its nutritive elements and of its moisture, and thus reduce the size of crops. They are mostly hardy, vigorous plants, and shade and choke out the more delicate plants of cultivation. Many fungous diseases of cereal, fruit, and other crops, such as rusts and rots, depend for their continuance upon weeds as intermediate hosts. Such weeds as the mustards are especially well known as the primary hosts of rusts. Some weeds poison stock; the spiny seeds or burs of others lessen the value of wool, besides being the cause of annoyance to all animals on the farm and to man. In these and in a thousand other ways weeds injure the farmer. They are present everywhere, and their numbers are limited only by the capacity of the soil and the extent of available space. Passing to particular examples of their fecundity, we may mention that a single plant of foxtail (Plate II, fig. A), the seeds of which were eaten by nearly 350 of the horned larks examined, has been known to produce 113,000 seeds, and a plant of red root (tumbleweed), the seeds of which are the food next preferred, has produced 115,000 seeds. Such reproductive powers if unchecked would result soon in covering the entire surface of the earth with weeds. Even as it is, the surface soil contains so many seeds that they often seem to constitute a considerable percentage of its bulk. At Ames, Iowa, a square rod of ground in a garden, which had been in potatoes the year before and cultivated with a hoe, yielded 187,884 plants of eight common weeds.[a] Crab grass and its allies, which are great pests in permanent lawns, and the seeds of which are eaten freely by the horned larks, occur in even greater number. Professor Beal states that each square quarter of an inch in his garden in Maryland, when first cultivated in the spring, contained at least one plant of crab grass. Upon this basis the number of plants to a square rod is 627,264. Three times the weeds were cut off, but each time they appeared in as great numbers as before.

The above statements indicate the vast numbers of weeds on farms, and show that to prevent them from possessing the land they must be destroyed in all stages of growth. The damage they cause, reckoned

[a] Bulletin No. 70, Exp. Sta., Ia. State College, p. 465, 1903.

in dollars and cents, is enormous. The Botanist of the Department of Agriculture says:

> The direct loss in crops, the damage to machinery and stock, and the decrease in value of land due to weeds, amount without question to tens of millions of dollars each year—a loss sustained almost wholly by the farmers of the nation.[a]

To limit the loss caused by them an unending warfare must be waged by the farmer. Any allies in this defensive warfare should be welcomed, and of such allies the seed-eating birds are the most important. The farmer, by the expenditure of time and labor, can destroy the weeds when they have sprouted, or later before they have ripened seed. But the seeds which are on and in the ground and which remain there for an indefinite period awaiting favorable opportunity for germination, it is not practicable for man to destroy. This portion of the work the birds attend to, and among the birds most actively engaged in consuming weed seeds the horned larks are conspicuous. Weed seeds are by far the largest single component of their food (63.9 percent), and over 1,070 birds of the number examined had eaten them, no fewer than 206 individuals having fed upon them to the exclusion of everything else. There can be no doubt of the fact that the horned larks display a preference for weed seeds and depend upon them as the *pièce de résistance* of every meal.

The larks, unlike some other species, do not perch upon weeds and peck apart the heads, thus assisting in scattering the seed, and it is in the last degree improbable that any of the seeds they eat pass through the alimentary canal in a condition to germinate. They have strikingly large and muscular gizzards, which seem specially adapted to dealing with hard and tough-coated seeds, and, moreover, they eat a great quantity of gravel. It has been found that as the result of the combined action of the gizzard and the gravel every kind of seed eaten by this lark is crushed. Even the exceedingly hard nutlets of *Lithospermum* succumb to its action. Cherry pits, which are very hard and of a shape most difficult to crush, are broken; minute seeds, such as those of amaranth and oxalis are ground up, and their fragments in the stomach resemble red pepper. Among the weeds the seeds of which furnish grist for these destructive mills are some of the worst pests in the country. Of a list of 100 weeds which are regarded as the most troublesome in the United States, the seeds of no fewer than 38 are included in the diet of these birds. Of this number the foxtail grasses, smartweeds, bindweeds, amaranth, pigweeds, purslane, ragweed, and the crab and barn grasses are conspicuous. The seeds of foxtail head the list, being found in 347 stomachs examined. Over 300 birds had eaten the seeds of amaranth (fig. B) and nearly 260 those of pigweed.

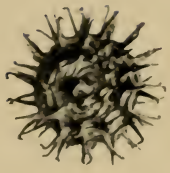
[a] Coville, in Farmers' Bulletin No. 28 (Weeds; and how to kill them; by L. H. Dewey), p. 3, 1895.

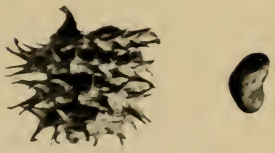


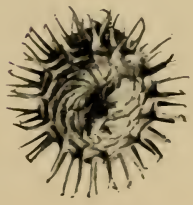
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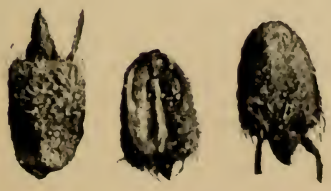
C



E



F



G

SEEDS OF CERTAIN TROUBLESOME WEEDS EATEN BY HORNED LARKS.

Fig. A.—Green and yellow foxtail (*Chætochloa viridis* and *C. glauca*). Fig. B.—Amaranth (*Amaranthus blitoides*). Fig. C.—Sedges (1, *Cyperus;* 2, *Scirpus;* 3, *Carex;* 4, *Rhynchospora*). Fig. D.—Bur clover (*Medicago denticulata*). Fig. E.—Napa thistle (*Centaurea melitensis*). Fig. F.—Corn cockle (*Agrostemma githago*). Fig. G.—Button weed (*Diodia teres*).

[A, F, G, Magnified 4 times; C, D, E, magnified twice; B, magnified 17 times.]

Smartweed and bindweed were eaten by 187 birds, crab grass by 154, and the seeds of sedges by more than 150.

The last are harsh, coarse plants, unsuited for forage, but which often adulterate forage crops injuriously. Grass and sedge seeds (fig. C) form 26.21 percent of the food of the horned larks. Some of these seeds are very small, and a great number of them are taken by the birds at a meal, no fewer than 500 having been found in a single stomach. An equal number of the tumbleweed seeds have been eaten by one bird, but of most kinds 100 is a fair meal, and this number of foxtail seeds is often taken. As a rule, however, the horned larks do not make an entire meal of one kind of food, nor do they show a decided preference for particular weed seeds, as appears from the very large number of kinds eaten, no fewer than 90 species of weed and grass seeds having been identified in their food.

Besides the common weed pests before mentioned, many other weeds, harmful in some or all parts of the country, are comprised in this list. Black mustard and wild radish, common pests in grain fields, are eaten whenever found. These weeds are especially injurious in California. Some others, which are only too well known in the same State, are eaten freely by the horned larks. The little plant known as red maids (*Calandrinia*), which is very hard to extirpate, produces a myriad of small black seeds, which are a favorite food of the larks of California. Filaree (*Erodium*) and the chickweeds (*Silene* and *Stellaria*) are very persistent weeds in cultivated ground, and again, their seeds form a conspicuous portion of the food of the horned lark. Bur clover (*Medicago denticulata*) (fig. D), very injurious to sheep-raising interests, and the Napa thistle (fig. E), or tocalote (*Centaurea*), a most formidable weed pest in both fields and pastures, are eaten. The common sunflower, harmless in the East, but most troublesome in many parts of the West, has large, nutritious seeds, which are often found in the stomachs of the larks. Dandelion, hoary vervain, and dog fennel are three others of the list of the '100 worst weeds' which are eaten. The seeds of plants of the genus *Solanum* also, one of which is the troublesome horse nettle, though small, are not overlooked. Among the poisonous plants the seeds of which are a part of the food of the horned larks is corn cockle (*Agrostemma githago*) (fig. F). The seed of this plant is a serious component of the wheat crop, as its weight and size make its separation from the wheat difficult. Animals are sometimes poisoned from eating wheat with cockle in it, and fatal cases of poisoning have been known of men who had eaten flour made from such grain. The birds apparently are not affected by the poisonous qualities of the seeds. Corn cockle is also a bad crop-choking weed, and in eating its seeds the larks confer a double benefit. Pokeweed, another poisonous species, sometimes

injurious to cattle, produces seeds which are eaten by the horned larks. Lamb's quarters, buttonweed (fig. G), whitetop, and corn spurry are among the other well-known weed seeds consumed.

### Fruit.

A few seeds of cultivated fruits were found in the horned larks' stomachs. These were of blackberry, pear, and cherry. No fruit pulp was found, and the seeds were probably obtained from garbage heaps, where these birds sometimes feed. But one-fifth of 1 percent of the total food of the year is fruit, and nearly all of this is taken in the winter months. Evidently the horned larks have little taste for fruit, and the quantity they get is too insignificant to be of economic value.

### Miscellaneous Vegetable Food.

Among the miscellaneous vegetable matter of no economic importance eaten by the larks were bits of grass roots and stems, a few flowers, and fragments of other tissues of plants. One stomach contained algæ, which had been obtained in a marsh. A few seeds, recognizable only as those of plants of the mint and carrot families, were found. Giraud reports that he found bits of seaweed in the stomachs of larks.

In summing up this part of our subject it may be said that horned larks are among the most efficient weed-destroying birds, and, as we have just seen, not a few of the weeds they eat are among the worst pests of cultivated land.

## ANIMAL FOOD.

The animal food of the horned lark, comprising 20.6 percent of the yearly diet, is made up entirely of invertebrates. It consists principally of insects, but is of great variety, as appears from the following list: Beetles, butterflies, grasshoppers, moths, ants, spiders, flies, wasps, thousand-legs, mites, centipedes, snails, periwinkles, bits of crab, mussel, and oyster shell, earthworms, termites, and ant-lions. Not only are the adult forms of the above eaten, but also the eggs, cocoons, and larvæ of many of them. Thus the horned lark does effective work in thinning out many forms of invertebrate life.

### Insects.

There are more harmful than beneficial families of insects, and the influence of the injurious kinds greatly overbalances that of the others. Many species, however, are valuable allies of the farmer, and successful agriculture would be well-nigh impossible without them. For the purposes of economic ornithology, only a few groups are considered beneficial. These are chiefly the parasitic hymenoptera, which destroy many injurious insects, and the predaceous beetles. That the latter

are not entirely useful, and that they sometimes attack cultivated crops, has been shown by various authors. These insects together make up only one-fourth of 1 percent of the food of the horned larks, which may be said, therefore, to eat practically no insects of value to man. Predaceous beetles of one family, the *Carabidæ*, live on the surface of the ground, where the horned larks obtain all their food, and it is strange that so few are eaten. As these insects are usually active only at night, and remain concealed by day, they are well protected; but some birds eat considerable numbers of them. Of the few found in the stomachs of horned larks only one species, *Agonoderus pallipes*, can be identified. This beetle (fig. 3) is known to feed upon the chinch bug, but about half of its food is vegetable, partly grass seed. Its economic relations, then, are about evenly balanced, and its wholesale destruction would be a loss. Only 15 of the 1,154 birds examined had eaten any carabids, and these insects represented but 0.16 percent of the total food. Thus the destruction of these insects by the horned lark is too slight to be noticed. Tiger beetles, another group of predaceous beetles, are also very scantily represented in the food of the horned larks. Although the larks often feed on the sandy beaches and roads where these active insects are most abundant, only two of them had been secured by the birds examined.



FIG. 3.—Predaceous beetle (*Agonoderus pallipes*). (From Riley, Bureau of Entomology.)

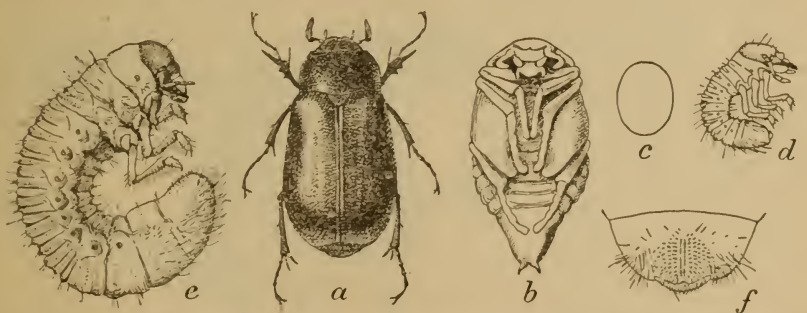



FIG. 4.—June bug (*Lachnosterna arcuata*) and its larva, a white grub. (From Chittenden, Bureau of Entomology.)

Taking up the injurious species, it was found that several horned larks had eaten click beetles, both in the adult and larval stages. The larvæ are the wireworms which are injurious to grain crops. The greater number of these were eaten in May. Among other beetles eaten, the dung beetles and other scavengers of the family *Scarabæidæ* are of little economic interest, and together with the leaf chafers of the same family they comprise a little over 1 percent of the food of the year. All the leaf chafers, however, which include the June bugs (fig. 4)

and their larvæ, the white grubs, are injurious. In the month of May 8.75 per cent of these are taken. The leaf beetles or chrysomelids form a slightly larger portion of the food taken than the scarabæids. The largest percentage, 4.1, of these eaten in any month is in August. In this family are found the harmful flea beetles, several species of which have been identified from stomachs of horned larks. *Haltica ignita*, which it is thought is likely to become decidedly injurious to strawberries and other plants in many parts of the country, and *Phyllotreta vittata* (fig. 5), a species very destructive to young plants of cabbage and other garden vegetables, are eaten by the larks. The pale striped flea beetle (*Systena blanda*) (fig. 6), injurious to melons, sugar beets, etc., has been found in their stomachs. Passing to another family, the blister beetles, which often feed upon the leaves of potato vines, are also eaten by the horned larks.

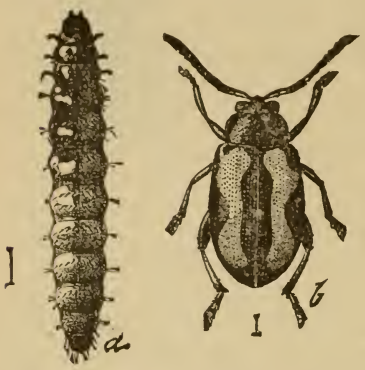



FIG. 5.—Destructive flea-beetle (*Phyllotreta vittata*). (From Riley, Bureau of Entomology.)

The most conspicuous element of the insect food, however, is weevils. These dull colored little beetles are eaten in every month in the year, and comprise 4.5 percent of the entire food of the horned larks. In May and June they form more than 8 percent of the food, and in August 18 percent. One hundred and fifty-nine birds ate them to the extent of 28.7 percent of their food. The weevils, as above stated, are dull and protectively colored, and when disturbed feign death and drop to the ground, where their resemblance to bits of twigs or seeds enables them to escape detection. This device, however, seems to be of little avail when the sharp eyes of the horned larks are concerned. Most of these little beetles are injurious, and some are among the worst of pests. The imbricated-snout beetle (fig. 7), which injures apple and cherry trees and strawberry plants, is often eaten. Eight California larks devoured more than 45 yucca weevils, the birds having an average amount of 84 percent of these insects in their stomachs. Of the curculionids, or true snout beetles, *Sitones* injures grass roots and *Phytonomus*

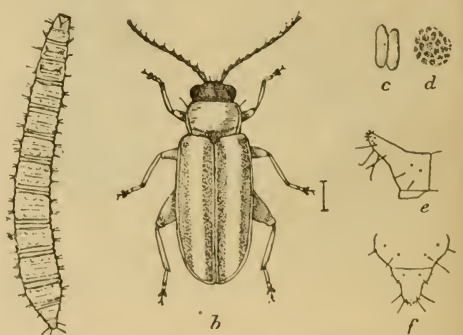



FIG. 6.—Pale striped flea-beetle (*Systena blanda*). (From Chittenden, Bureau of Entomology.)

attacks clover. Both of these beetles are eaten by the horned lark. The potato stalk borer (*Trichobaris trinotata*), the nut weevils, and grain weevils are all taken. Weevils in the lark's diet take the place of grasshoppers, which are the predominant element of the insect food of granivorous birds. The percentage of grasshoppers eaten by the larks, 2.5, is somewhat more than half that of the weevils consumed. In August and September, the months during which grasshoppers are most abundant, 7.1 and 8.9 percent, respectively, are consumed by horned larks. Grasshoppers were obtained in every month in the year except November, December, and January. During the great invasions of locusts that have occurred in the United States horned larks have been efficient in their destruction, and they are reported to have eaten both eggs and adults.




FIG. 7.—Imbricated-snout beetle (*Epicærus imbricatus*). (From Chittenden, Bureau of Entomology.)

Caterpillars, cocoons, and adults of lepidoptera are eaten by horned larks. The larvæ of the tineid or leaf-mining moths (fig. 8), which are injurious to various nuts, fruits, and stored grain, and even to furs, are a favorite food. In the winter many of these are picked from their places of concealment. Three horned larks collected in March in Wyoming had eaten more than 30 each, making 80 percent of their food. Among the caterpillars, geometrids, or measuring worms, were identified. Most of the caterpillars are eaten in April and May, 5.8 and 6.2 percent, respectively, being taken in these months. Concerning the value of the horned lark in destroying cutworms, the caterpillars of the owlet moths, Dr. Le Baron says:[a]

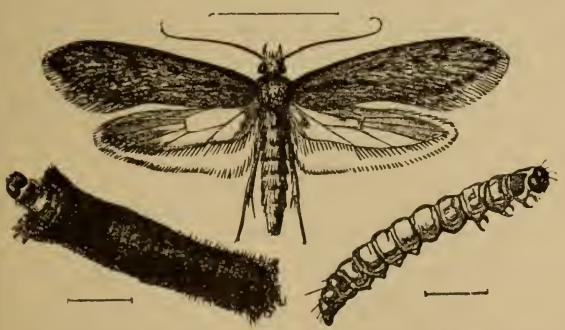


FIG. 8.—Tineid moth with larva and cocoon. (After Riley, Bureau of Entomology.)

> The peculiarity of this bird * * * is the instinct with which it discovers and destroys those grubs which infest cornfields, and which often do so much damage to this and other crops. It came to my knowledge through the observation of an

[a] The American Entomologist and Botanist, II, No. 6, p. 168, April, 1870.

intelligent and observing farmer in my neighborhood upon whose accuracy entire dependence can be placed.

While going through with the first hoeing of his corn, he observed running about among the hills little grayish birds, which, from his description and from the absence of any similar bird with which it could be easily confounded, I have no doubt was the present species. Upon observing one of them more attentively, he became interested in watching its operations. Running along near the hills, it stopped abruptly from time to time opposite a hill and stood still as if listening; then, having apparently determined its direction, it inserted its bill at a short distance from a spear of corn, and by a rapid rotary motion partially buried itself in the loose earth, and then jerking backward dragged out a large grub, which from its situation may be reasonably supposed to be one of those larvæ, of which there are several different kinds, known by the name of cutworms. Taking this worm in its bill, it ran along until by its acute sense of hearing or by some other instinct it became aware of the presence of another of its insect prey. Then laying down the one previously obtained it quickly dislodged another in the same manner, and seizing them both in its bill again pursued the search. Having obtained as many as it could carry, it flew off to the neighboring grass field, having in all probability a brood of young awaiting its arrival. Not infrequently one of these small birds would carry off four or five grubs at once, often having to lay them down and take them up several times before it could get secure hold of them all.

When we consider how common these birds are, it is easy to conceive that they must destroy an immense number of larvæ in the course of the season.

While writing this article I have obtained several specimens of this kind of bird, both male and female, for the purpose of identifying the species with certainty. Upon examining the contents of the stomach, I found in most of them several grains resembling hulled oats, and in one of them was a larva nearly 1 inch in length, of a pale-green color, with a brown head and tapering a little at each end, being different from the cutworm, but resembling and perhaps identical with the spindle worm, so called, which burrows into the stem of the corn plant. It would be a curious fact if it should prove that the bird possesses the instinct to detect and destroy two noxious larvæ so different in appearance and habits as those here mentioned.

Thus does this shy and unobtrusive little bird perform its humble but useful part in the economy of nature, and while seeking a subsistence for itself and young unconciously renders an important service to the husbandman.

Next in importance to the beetles as an element of the horned lark's food are bugs. Eggs, young, and adults are eaten, and representatives of 12 families of these insects had been consumed by the birds examined. Practically all the bugs eaten are injurious, some of them especially so. The tarnished plant bug (*Lygus pratensis*) (fig. 9), which is very destructive to all orchard fruits and to strawberries, and the green tree bug (*Nezara hilaris*), one of the offensive stink-bugs sometimes found on grapes, are devoured. The chinch bug (*Blissus leucopterus*) (fig. 10), among the worst of all insect pests, was eaten in March, May, and June. The losses caused by this insect have been estimated for single years throughout its range at above a hundred million dollars. One stomach of a horned lark collected in May contained 34 entire chinch bugs and fragments of 16 more, or a total of 50 eaten in a morning.

Among other insects, ants and wasps taken together are but little over one-half of 1 percent of the year's food. The beneficial species consumed were ichneumon flies, but they make up only 0.07 percent of the total food. Ants at certain times are eaten freely, especially by California larks. These insects are considered more injurious than beneficial. None of the other components of the animal food amounts to 1 percent of the food of the year. Spiders are obtained in every month, the greatest number being taken in May. Flies and their larvæ are eaten whenever found, the greatest number in June. Dipterous larvæ, which live in the brine of salt tanks on the Pacific coast, are among those eaten, 20 of these being found in one stomach. Thirty-three larvæ of the common house fly were eaten at one meal by another bird. Termites or white ants were devoured by California larks in October, and the creatures known as ant-lions (*Myrmeleonidæ*) were a part of the food in May, June, and July, most of these being eaten by Kansas horned larks.



FIG. 9.—Tarnished plant bug (*Lygus pratensis*). (From Chittenden, Bureau of Entomology.)

### MISCELLANEOUS ANIMAL FOOD.

Twenty-two birds had eaten animal matter which may be classed as miscellaneous. One had eaten three or four earthworms. Fragments of hundred-legs and thousand-legs were found in a few stomachs. A mite was found among some algæ picked up by one of the birds. Several larks which were shot on beaches had gathered a few small periwinkles, but whether these were taken for food or as an aid in grinding food is a question. Bits of oyster, mussel, and crab shell were probably taken for the latter purpose. One or two snails also were eaten.

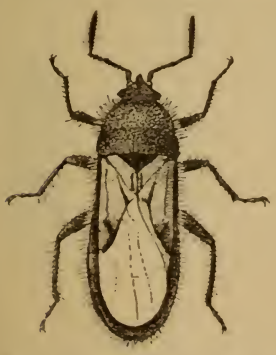


FIG. 10.—Chinch bug (*Blissus leucopterus*). (From Webster, Bureau of Entomology.)

So far as its animal diet is concerned, the horned lark is exceedingly beneficial. It consumes more or less animal matter in every month of the year, and from May to August nearly one-half its food is of animal nature, chiefly insects. These consist largely of species which if unchecked would soon render agriculture impossible. Feeding as it does on the ground in the midst of the crops which the insects threaten to destroy, the horned lark is one of the most efficient natural checks upon their numbers, and it is difficult to overestimate the value of the service thus rendered.

### MINERAL MATTER.

Horned larks use a very large amount of gravel to assist in grinding their food, and, strange as it may seem, nestlings have more of it in their stomachs than adults. Five stomachs of nestlings which contained no food material except of an animal nature held an average of 21 percent of gravel. Now, it has been supposed, since granivorous birds usually eat much gravel, and since exclusively insectivorous birds, such as cuckoos, take almost none, that its function is the crushing and grinding of seeds to aid in their digestion. But why the thin-walled stomach of fledglings which are fed almost exclusively on soft animal foods should contain so much gravel is a question for which no satisfactory answer has yet been found. The percentage for the nestlings is 21.8, for the adults 18.4, and for the birds in first plumage 14.9. The last group is the most vegetarian of the three, but, oddly enough, takes the least grinding material. The mineral matter consists principally of coarse and fine sand, sandstone, quartz, and cinders. Many bits of fossils were found, among which were fragments of foraminifera, brachipods, sea urchins, corals, bryozoans, and crinoids.

## NESTLING AND OTHER YOUNG HORNED LARKS.

As with most of our common birds, nestlings of the horned larks are more insectivorous than older individuals, although while still in the nest they are sometimes fed considerable vegetable matter. From the present investigation the ratio of vegetable to animal food is found to be 16.3 to 83.7.

A thorough study of the diet of the nestling larks requires a larger amount of material than is available. Ten stomachs have been examined, which were taken in three States, from April to July, inclusive. Those obtained early in the season, and from northern States, contained the largest amounts of vegetable matter. Of these, three contained 1, 8, and 40 percent, respectively, and two 50 percent, of vegetable substances. A nestling taken in April in New York had been fed 45 percent of wheat. This consisted of whole grains, which would seem to be rather unsuitable food for a fledgling. The other vegetable matter found in the stomachs of nestling larks was mainly weed seeds. Among them were green foxtail (*Chætochloa viridis*), tumbleweed (*Amaranthus*), and yellow sorrel (*Oxalis stricta*).

In the animal matter were wireworms (*Elateridæ*), other beetle larvæ, mainly white grubs (*Scarabæidæ*), adult beetles, such as scarabæids, leaf beetles (*Chrysomelidæ*), pill beetles (*Byrrhidæ*), and weevils (*Rhynchophora*). The latter were found in all but three of the stomachs and formed 16.3 percent of the total food of the nestlings. Of the chrysomelids, one stomach contained fragments of at least 50 individuals

of the greater striped flea-beetle (*Disonycha caroliniana*) (fig. 11), a foliage-feeding species. The most important element of the animal food, however, was grasshoppers (*Acrididæ*). These comprised 41.5 percent of all the food, and no less than 99 percent of the contents of one of the stomachs. Grasshoppers are a favorite diet for the nestlings of many birds, and sometimes are fed to them almost to the total exclusion of other foods. Prof. Samuel Aughey, in Nebraska, during the month of May, found the horned larks feeding almost wholly upon young grasshoppers, great numbers of which they were carrying to their nestlings. The stomach of one lark was found to contain 42 locusts and 33 small seeds.[a]



FIG. 11—Greater striped flea-beetle (*Disonycha caroliniana*). (Three times natural size.)

Other animal matter fed to the nestlings examined by the writer consisted of chrysalids of leaf-mining moths (*Tineidæ*), leaf bugs (*Capsidæ*), spiders, ant-lions (*Myrmeleonidæ*), thirteen of which formed 60 percent of the contents of one stomach, and centipedes (*Chilopoda*).

In the nestling state, therefore, horned larks are almost entirely beneficial, and the number of insect pests they consume is very great. Adults have been seen to carry food to the nest twenty times in an hour, and they continue their visits throughout the day for a week or more; and it is to be remembered that this species raises two or three broods in a year. Each family thus destroys a host of insects, and the quantity consumed by the birds throughout North America is almost beyond computation. As our examinations show that weevils and grasshoppers compose the great bulk of the insect food of the nestlings, their economic value can hardly be overestimated.

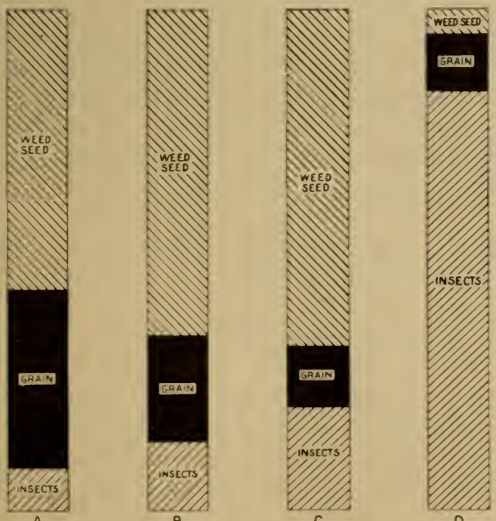



FIG. 12.—Columns showing the proportions of insects, grain, and weed seed eaten by the following: A, California larks; B, larks in first plumage; C, total number examined exclusive of California birds; D, nestlings.

Concerning the fully fledged young, Professor Barrows noted that they eat less animal matter than the adults, a conclusion confirmed by examination of the more abundant material now available (see fig. 12).

[a] First Ann. Report U. S. Entom. Comm., App. II, p. 18, 1878.

One hundred and four birds in first plumage were taken in seven of the twelve months. The average amount of animal food eaten by them was 13.47 percent, 7.15 percent less than the quantity consumed by the adults. There is, in fact, no month in which they do not eat less animal matter than the old birds; thus in January they get none at all, in May they consume not quite 1 percent less than the adults, in June 25.1 percent less, in July 5.81 percent less. In August three young birds had eaten an average of only 0.5 percent of animal food, which is over 43 percent below the amount taken by the adults in the same month. In September three birds obtained 5.33 percent, or 9.27 percent less than the old birds. In October only one immature bird was collected, and it had eaten 5 percent of animal matter, which was more than 9 percent less than the average amount taken by the adults during that month.

In May, June, and July the birds of the year, although they consume less animal food than the adults, get more than the average amount for the species, and perhaps they are fed to some extent by the adults. In August, September, October, and January, as we have seen, they either care little for animal food or, as is more likely, are unable to procure it from want of skill. The latter conclusion seems all the more probable, since it is in the first-named month that the adults consume the maximum amount for the year.

If comparison of the animal food of adults and young (exclusive of nestlings) is confined to the months in which the latter were collected, the young fall more than 15 percent below the average of their parents, and, be the reason what it may, the fact remains that in the month of January and from May to October, inclusive, the birds of the year consume less than half as much animal matter as the adults.

## FOOD OF THE HORNED LARKS OF CALIFORNIA COMPARED WITH THAT OF THE OTHER FORMS.

The food habits of the California subspecies (*Otocoris alpestris actia*) were found to differ so remarkably from those of the other horned larks as to merit separate notice. Briefly stated, the difference consists in the high percentage of vegetable—as compared to the animal—food consumed by the California birds. Proceeding to details it will be seen from the accompanying chart (fig. 13) that the quantity of animal matter consumed fluctuates irregularly throughout the year, obeying no obvious law. No stomachs were collected in May, and the number for some other months is too small to furnish reliable results, but the aggregate for the year, 267, is quite sufficient to give a good idea of the food of the subspecies.

No nestlings of the California lark were examined. The first brood of these is said to be hatched in April or May, and the percentage of animal matter consumed by the California larks in these two months

would probably be largely increased if nestlings had been included in the examinations. It appears that the highest percentage of animal matter is taken in June. This, however, is only 27.7 percent, not much more than half the highest monthly average for the other members of the species. This small percentage appears the more remarkable when it is stated that the birds collected in June in California were from places where insect life abounds. Some came from the salt marshes, where fly larvæ are numerous, and others from beaches where small chrysomelids are plentiful. In most localities, however, insects are scarce during the dry season, but almost everywhere there is an abundance of vegetable food accessible to the larks. All of the weeds, except the tarweeds and a few other drought-resisting species, dry up, and a litter of broken plants, which contains many seeds, covers the surface of the ground. Ants and grasshoppers are the only insects found in any numbers in these 'dry pastures.' It is therefore not surprising that vegetable food composes 91.44 percent of the diet of the California horned larks, while the larks in the remainder of the country take less than 80 percent of the same class of food. Of the vegetable matter, weed seed, which is 51.1 percent, is less than the amount of the same kind of food taken by the other horned larks. The rest of the vegetable food, 40.2 percent, is grain, including that from wild as well as from cultivated plants. Hence the most serious complaints of the grain-feeding habits of the larks come from California, and the foregoing facts partially justify them.

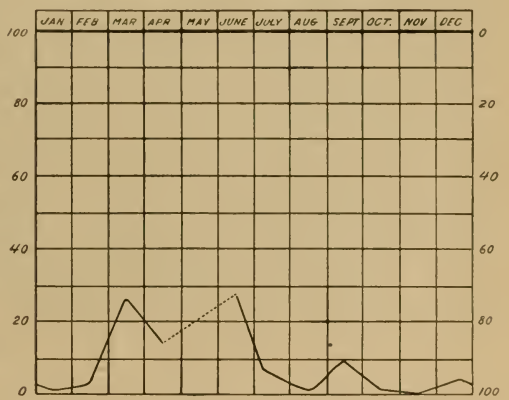



FIG. 13.—Diagram showing the proportions of animal and vegetable food of the California horned lark for every month in the year.

Of the 98 horned larks examined which had eaten wheat, 23 came from California. Two hundred and one had eaten oats, and 130 of these were from California. Of the grain eaten by the horned larks of California, 31.1 percent consists of oats and 9.1 percent of wheat, corn having been eaten by but one bird. Oats, then, are the favorite food, and on this account the horned larks are liable to damage the crop. However, a great part of the oats consumed probably comes from the wild plants so abundant in all parts of the State, and the destruction of these is a benefit.

The California horned larks consume only 8.56 percent of animal food, while the other forms collectively eat 20.61 percent. Consider-

ation of the food habits of this subspecies indicates how powerfully local conditions, such as the abundance or scarcity of certain foods, affect the economic value of a bird. Horned larks, like other birds, naturally have recourse to the foods which are most abundant and most accessible, the ubiquitous wild oats being, in the case of the California birds, by far the greatest single element of their diet.

In California, then, where they depend chiefly upon grain for food, the horned larks may do considerable harm, especially when they are very numerous. Elsewhere in the United States, other foods being generally abundant, grain is taken only incidentally and little injury is done.

## SUMMARY.

Examination of 1,154 stomachs collected in all parts of the United States and southern Canada shows that the food of the horned larks consists of insects, 20.6 percent, and vegetable matter, nearly six-sevenths of which are weed seed, 79.4 percent.

The nestlings are highly insectivorous, but soon after leaving the nest they become much more vegetarian than even the adults.

The horned larks of California differ markedly in food habits from those of other parts of the country, being almost entirely vegetarian, and although the number examined constitutes little more than a fifth of the total, yet they consume half of all the grain eaten by the whole group. Below are contrasted the amounts of grain eaten by the horned larks of California and of other States:

| Grain. | California. | Elsewhere. |
|---|---|---|
| | *Percent.* | *Percent.* |
| Oats | 31.1 | 4.86 |
| Wheat | 9.1 | 1.66 |
| Corn | Trace. | 4.97 |
| Buckwheat | None. | .68 |
| Total | 40.2 | 12.2 |

From the above facts and figures it might appear that the California horned larks are decidedly injurious, but the quantity of oats eaten as indicated by the ratios does not fairly represent the birds' economic status, since a large proportion of this grain is wild and hence of no value to the farmer.

Of the grain eaten in the other States, buckwheat is a negligible amount, while practically all of the corn and oats eaten is waste. Although the Great Plains region, the most important wheat-growing area of the country and also the center of abundance of the horned larks, is represented by a proportionate number of the stomachs examined, yet the percentage of wheat eaten is only 1.66. In fact, the

larks of this region, considered separately, are even more insectivorous than those from east of the Mississippi, one-fourth of their food being animal matter.

The charges made by farmers that the horned larks eat newly sown grain are confirmed, but in attempting to estimate the economic value of the birds it must be borne in mind that the insects they eat compensate many fold for the seed grain taken, even considered bulk for bulk. As a matter of fact, however, the insects eaten constitute almost twice as great a proportion of the food as the grain, including even that which is waste. As may be seen from the foregoing table, the grain-eating proclivities of the bird in most parts of the country result in very little damage to the farmer. Furthermore, even this small amount of injury is preventable by the use of a deep-planting drill in seeding.

It is impossible to estimate in dollars and cents the benefits resulting from the work of the horned lark, but it is none the less real on that account. Moreover, the services of the bird cost the farmer practically nothing save a small toll levied here and there upon seed grain. So small in amount is the grain thus taken and over such restricted areas that, aside from the fact that at small expense all damage can be prevented, the loss bears no comparison to the benefits conferred. The horned lark by its services to agriculture earns a right to live, and deserves protection at the hands of man.

## LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE HORNED LARKS.

### GRAIN.

Corn (*Zea mays*).
Kafir corn (*Andropogon sorghum*).
Oats (*Avena sativa*).
Wheat (*Triticum sativum*).
Buckwheat (*Fagopyrum fagopyrum*).

### FORAGE PLANTS.

Paspalum (*Paspalum* spp.).
Hungarian grass (*Chætochloa italica*).
Timothy (*Phleum pratense*).
Red-top (*Agrostis alba*).
Orchard grass (*Dactylis glomerata*).
Kentucky bluegrass (*Poa pratensis*).
Rape (*Brassica napus*).
Alfalfa (*Medicago sativa*).
Red clover (*Trifolium pratense*).
White clover (*Trifolium repens*).

### WEEDS AND WILD FRUITS.

Eel grass (*Zostera marina*).
Large crab grass (*Syntherisma sanguinalis*).
Small crab grass (*Syntherisma linearis*)
Barnyard grass (*Echinochloa crus-galli*).
Witch grass (*Panicum capillare*).
Yellow foxtail (*Chætochloa glauca*).
Green foxtail (*Chætochloa viridis*).
Rough rush grass (*Sporobolus asper*).
Sheathed rush grass (*Sporobolus vaginæflorus*).
Wild oats (*Avena fatua*).
Wire grass (*Elcusine indica*).
Stink grass (*Eragrostis major*).
Club rush (*Scirpus* sp.).
Sedge (*Carex* sp.).
Rush (*Juncus* sp.).
Field sorrel (*Rumex acetosella*).
Western dock (*Rumex occidentalis*).
Curled dock (*Rumex crispus*).
Dense-flowered persicaria (*Polygonum portoricense*).
Pale persicaria (*Polygonum lapathifolium*).
Pennsylvania persicaria (*Polygonum pennsylvanicum*).
Lady's thumb (*Polygonum persicaria*).
Smartweed (*Polygonum hydropiper*).
Knotgrass (*Polygonum aviculare*).
Black bindweed (*Polygonum convolvulus*).
Climbing false buckwheat (*Polygonum scandens*).
Lamb's-quarters (*Chenopodium album*).
Saltwort (*Salsola kali*).
Rough pigweed (*Amaranthus retroflexus*).
Slender pigweed (*Amaranthus hybridus*).

### WEEDS AND WILD FRUITS—continued.

Prostrate amaranth (*Amaranthus blitoides*).
Poke weed (*Phytolacca americana*).
Red maids (*Calandrinia menziesii*).
Miner's lettuce (*Montia perfoliata*).
Purslane (*Portulaca oleracea*).
Corn cockle (*Agrostemma githago*).
Wild pink (*Silene* spp.).
Chickweed (*Alsine* spp.).
Largermouse-earchickweed (*Cerastium vulgatum*).
Mouse-ear chickweed (*Cerastium* spp.).
Sandwort (*Arenaria* spp.).
Corn spurry (*Spergula arvensis*).
Black mustard (*Brassica nigra*).
Turnip (*Brassica campestris*).
Wild radish (*Raphanus raphanistrum*).
Cinquefoil (*Potentilla* sp.).
Wild red cherry (*Prunus pennsylvanica*).
Sensitive pea (*Cassia* sp.).
Lupine (*Lupinus* sp.).
Toothed medic (*Medicago denticulata*).
Melilot (*Melilotus* sp.).
Cutleaved cranesbill (*Geranium dissectum*).
Alfilaria (*Erodium cicutarium*).
Upright yellow wood sorrel (*Oxalis stricta*).
Milkwort (*Polygala* sp.).
Spotted spurge (*Euphorbia maculata*).
Spurge (*Euphorbia* sp.)
Supple-jack (*Berchemia scandens*).
New Jersey tea (*Ceanothus americanus*).
Mallow (*Malva alcea*).
Nuttall's dogwood (*Cornus nuttallii*).
Common milkweed (*Asclepias syriaca*).
Yellow bur-weed (*Amsinckia spectabilis*).
Hairy stickseed (*Lappula texana*)
Stickseed (*Lappula* sp.).
Corn gromwell (*Lithospermum arvense*).
Gromwell (*Lithospermum officinale*).
Hoary puccoon (*Lithospermum canescens*).
Narrow-leaved puccoon (*Lithospermum linearifolium*).
Blueweed (*Echium vulgare*).
Hoary vervain (*Verbena stricta*).
Blue curls (*Trichostema dichotomum*).
Nightshade (*Solanum* spp.).
Rough button-weed (*Diodia teres*).
Dandelion (*Taraxacum taraxacum*).
Small-flowered marsh elder (*Iva axillaris*)
Great ragweed (*Ambrosia trifida*).
Ragweed (*Ambrosia artemisiæfolia*).
Fleabane (*Erigeron* sp.).
Common sunflower (*Helianthus annuus*).

WEEDS AND WILD FRUITS—continued.

Sunflower (*Helianthus* spp.).
Tarweed (*Hemizonia fasciculata*).
Dog fennel (*Anthemis cotula*).
Common groundsel (*Senecio vulgaris*).
Common bur thistle (*Carduus lanceolatus*).
Napa thistle (*Centaurea melitensis*).

CULTIVATED FRUITS.

Blackberry (*Rubus* sp.).
Pear (*Pyrus* sp.).
Cherry (*Prunus* sp.).

BEETLES (COLEOPTERA).

Tiger beetles (*Cicindelidæ*).
Ground beetles and their larvæ (*Carabidæ: Agonoderus pallipes*).
Water scavenger beetles (*Hydrophilidæ*).
Rove beetles (*Staphylinidæ: Alcochara nitida; Xantholinus picipennis*).
Histerid beetles (*Histeridæ*).
Pill beetles (*Byrrhidæ*).
Click beetles and their larvæ, the wireworms (*Elateridæ: Drasterius* sp.; *Limonius plebejus*).
Fireflies (*Lampyridæ*).
Lamellicorn beetles and their larvæ, the white grubs (*Scarabæidæ: Onthophagus pennsylvanicus*; Dung beetles [*Aphodius fimetarius, A. rubricola*, and *A. inquinatus*]; June bugs [*Lachnosterna* sp.]; *Strigoderma arboricola*).
Long-horned beetles (*Cerambycidæ*).
Leaf beetles (*Chrysomelidæ: Donacia* sp.; *Pachybrachys* sp.; *Gastroidea* sp.; *Galerucella notata;* Grenter striped flea-beetle [*Disonycha caroliniana*]; Strawberry flea-beetle [*Haltica ignita*]; *Longitarsus lircus*; Striped flea-beetle [*Phyllotreta vittata*]; *Chætocnema denticulata; C. protensa;* Pale striped flea-beetle [*Systena blanda*]; *Anomœa* sp.; *Chrysochus auratus*).
Blister beetles (*Meloidæ:* Black blister-beetle [*Epicauta pennsylvanica*]).
Scarred-snout beetles (*Otiorhynchidæ:* Imbricated-snout beetle [*Epicærus imbricatus*]; Yucca weevil [*Rhigopsis effracta*]: *Rhypodes* sp. nov.).
True snout beetles (*Curculionidæ: Sitones flavescens; Phytonomus nigrirostris; Macrops ulkei; Copturodes adspersus;* Potato stalk borer [*Trichobaris trinotata*]; *Centrinus* sp.; *Tyloderma nigrum*).
Nut weevils (*Calandridæ*).
Fungus beetles (*Anthribidæ*).

GRASSHOPPERS (ORTHOPTERA).

Locusts, and their eggs and nymphs (*Acrididæ: Melanoplus* sp.).
Grouse locusts (*Tettix ornatus; Tettix* sp.).

BUTTERFLIES AND MOTHS (LEPIDOPTERA), INCLUDING CATERPILLARS, CHRYSALIDS, AND COCOONS.

Measuring worms (*Geometridæ*).
Leaf miners (*Tineidæ*).

BUGS (HEMIPTERA), INCLUDING EGGS AND NYMPHS.

Thread-legged bugs (*Emesidæ*).
Damsel bugs (*Nabidæ: Nabis ferus*).
Assassin bugs (*Reduviidæ*).
Leaf bugs (*Capsidæ:* Tarnished plant bug [*Lygus pratensis*]).
Chinch bugs (*Lygæidæ:* Chinch bug [*Blissus leucopterus*]).
Squash bugs (*Coreidæ*).
Stink bugs (*Pentatomidæ:* Green tree bug [*Nezara hilaris*]).
Burrower bugs (*Cydnidæ*).
Lantern flies (*Fulgoridæ*).
Spittle insects (*Cercopidæ*).
Leaf hoppers (*Jassidæ: Agallia sanguinolenta*).
Jumping plant lice (*Psyllidæ*).

ANTS AND WASPS (HYMENOPTERA).

Parasitic group: Ichneumon flies (*Ichneumonidæ*).
Nonparasitic group:
*Scoliidæ:* Black wasp (*Tiphia inornata*).
Ants (Formicina: *Formicidæ, Myrmicidæ*).

SPIDERS (ARANEIDA), INCLUDING EGGS AND EGG SACS.

Running spiders (*Lycosidæ*).
Jumping spiders (*Attidæ*).

FLIES (DIPTERA), INCLUDING LARVÆ AND PUPÆ.

Robber flies (*Asilidæ*).
*Muscidæ:* House fly (*Musca domestica*).

WHITE ANTS (ISOPTERA).

*Termes* sp.

ANT-LIONS (NEUROPTERA).

*Myrmeleon* sp.

## Among the other animal matter were the following:

Centipedes (*Chilopoda*).
Millipeds (*Diplopoda*).
Mites (*Acarida*).
Snails and periwinkles (*Gastropoda: Bittium nigrum* and *B. greenii*).
Bits of shells of oyster and mussel (*Lamellibranchiata*).
Carapace of crab (*Crustacea*).
Earthworms (*Chætopoda*).

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